

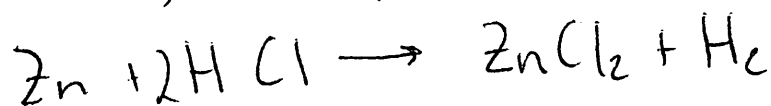
Ch 16 Acids

in most foods → fruit → citric, malic
milk lactic acid
vinegar
Soda

Props of acids

↳ 1. Sour taste (lemon - citric acid)

2. Contain H, react w/ metals to release H_2 gas



3. Change color of dyes

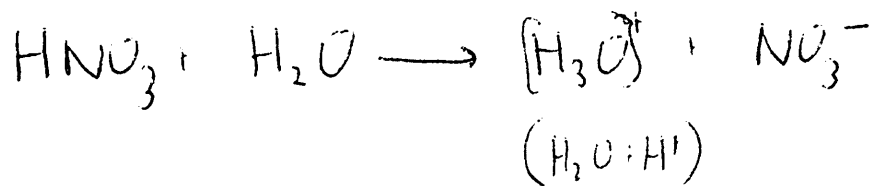
↳ indicators Ex. litmus (from lichens)

4. React w/ Bases to produce salts + H_2O (Neutralization)

5. They are electrolytes.

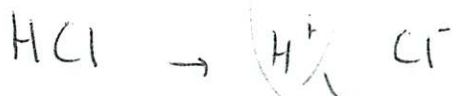
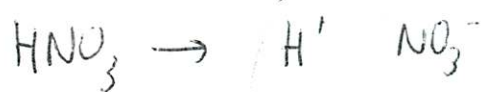
Arrhenius

Def → comp that ^{contains H} ^{produces} an H^+ ion (proton) in aqueous soln

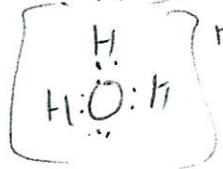
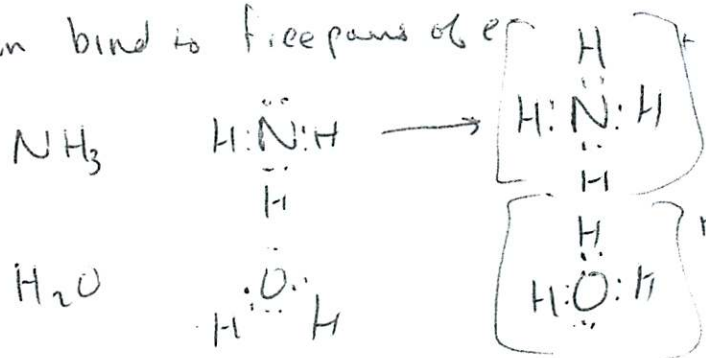


Types of acids (Classification)

Brønsted acids → any sub that donates proton (H^+)
↳ anything that



Protons can bind to free pairs of e^-



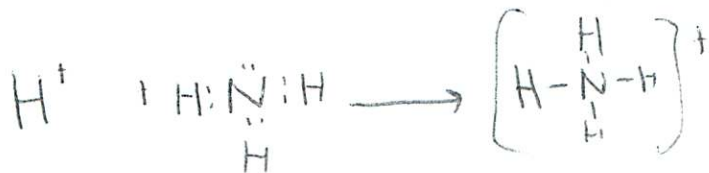
water also proton donor

Lewis Acids

↳ avoid def that depends on particular element.
role of e^- ~~pairs~~ pairs

↳ e^- pair acceptor → any molecule that ~~can~~ accept e^- pair to form covalent bond

a proton is a Lewis acid



Hawwk

464 Q2

475 Q2

479 Q1+2

(H 483 Q1+2)

486 Q1

AF

468 Q30 Prob2, 7, 8

489 Q9 Prob5

Apr

487
H 6a-f

488 Q1, 2, 5, 6, 8

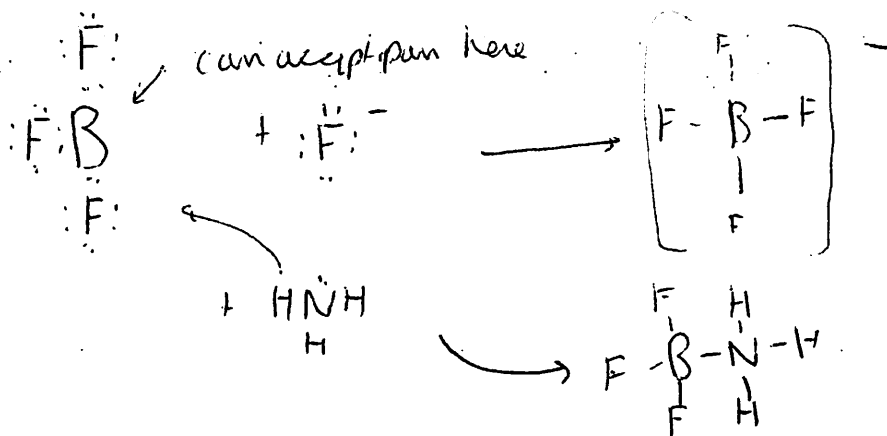
489 Q11, 12, 15, 16

489 Q11, 12, 15, 16

TABLE 16-7 RELATIVE STRENGTHS OF ACIDS AND BASES

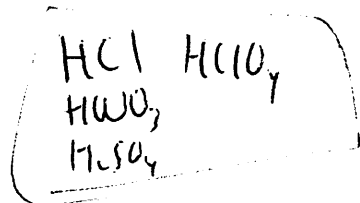
	Conjugate Acid	Formula	Conjugate Base	Formula	
↑ Increasing Acid Strength	perchloric	HClO ₄	perchlorate ion	ClO ₄ ⁻	↑
	hydrogen iodide	HI	iodide ion	I ⁻	
	hydrogen bromide	HBr	bromide ion	Br ⁻	
	hydrogen chloride	HCl	chloride ion	Cl ⁻	
	nitric	HNO ₃	nitrate ion	NO ₃ ⁻	
	sulfuric	H ₂ SO ₄	hydrogen sulfate ion	HSO ₄ ⁻	
	hydronium ion	H ₃ O ⁺	water	H ₂ O	
	hydrogen sulfate ion	HSO ₄ ⁻	sulfate ion	SO ₄ ²⁻	
	phosphoric	H ₃ PO ₄	dihydrogen phosphate ion	H ₂ PO ₄ ⁻	
	hydrogen fluoride	HF	fluoride ion	F ⁻	
	acetic	HC ₂ H ₃ O ₂	acetate ion	C ₂ H ₃ O ₂ ⁻	
	carbonic	H ₂ CO ₃	hydrogen carbonate ion	HCO ₃ ⁻	
	hydrogen sulfide	H ₂ S	hydrosulfide ion	HS ⁻	
	ammonium ion	NH ₄ ⁺	ammonia	NH ₃	
	hydrogen carbonate ion	HCO ₃ ⁻	carbonate ion	CO ₃ ²⁻	
	water	H ₂ O	hydroxide ion	OH ⁻	
	ammonia	NH ₃	amide ion	NH ₂ ⁻	
	hydrogen	H ₂	hydride ion	H ⁻	↓ Increasing Base Strength
					↑ Decreasing Base Strength

BF_3 good Lewis Acid



Types \rightarrow Strong acids - ionize 100% in aqueous soln

table 16-1 ex Perchloric, HClO_4

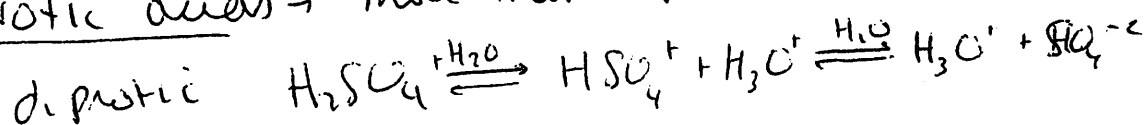


Hydrochloric HCl
Nitric HNO_3

all give up 1 proton $\rightarrow \text{HCl} \rightarrow \text{Cl}^- + \text{H}^+$

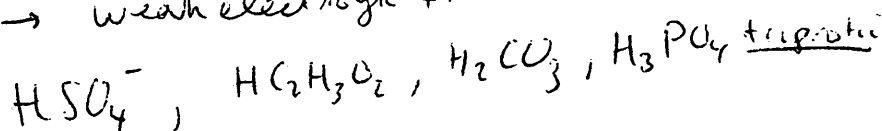
\hookrightarrow monoprotic acid

polyprotic acids \rightarrow more than 1 proton



~~triprotic~~

Weak acids \rightarrow weak electrolyte that is an acid



TTA

Naming acids → Recap

↳ Binary → H + 2nd Element.

↳ add prefix hydro give suffix -ic

HF Hydrofluoric acid

IONS

Oxgacids ate-ic de-ous

Chlorite ClO_2^- → Chlorous HClO_2

Never add water to acid

↳ spatters, heat released

DANGER

Do Back over
Naming

16.2 Gen props of Acids - Base Rxns

Props of Bases → Bitter taste

↳ Soap

produce OH^-

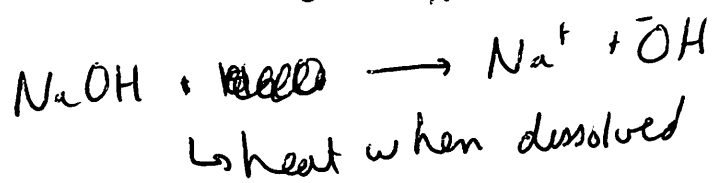
2. Dilute Base soln feel slippery

3. Change color of indicator dyes

4. React w/ acids → make salts + H_2O

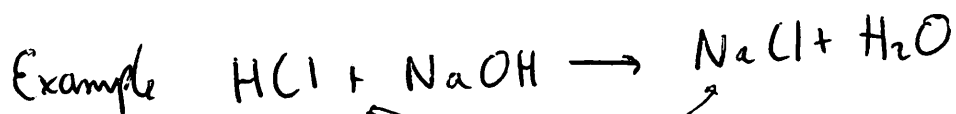
5. Electrolytes

Def of bases - Arrhenius - contains hydroxide and produces OH^- in aq soln.



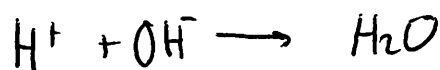
~~Base~~ ~~acid~~ base

Neutralization Rxn - $\text{H}^+ + \text{OH}^-$ to form H_2O

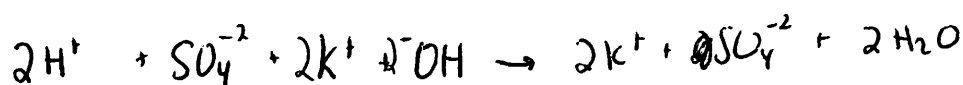


Note everything electrolytic

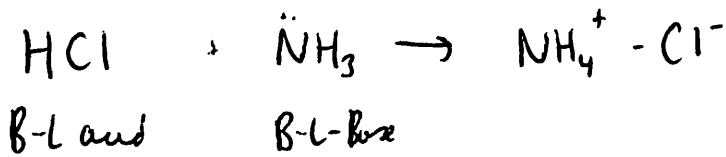
actual Rxn is



$\text{Na}^+ + \text{Cl}^-$ as ions @ start and @ end
↳ spectators



Brønsted-Lowry base - proton acceptor

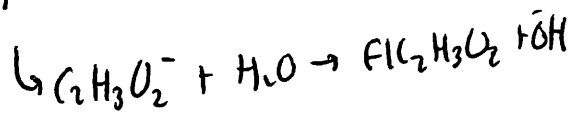


B-L-Box

→ in a B-L Rxn - protons transferred from acid to the base

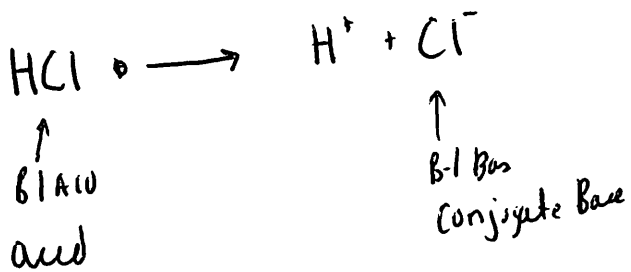
Type of bases \rightarrow Strong bases any gr 1 or 2 w/o OH is a strong base (but some gr 2 are not as soluble in H₂O)

Weak base - NH_3 , anions

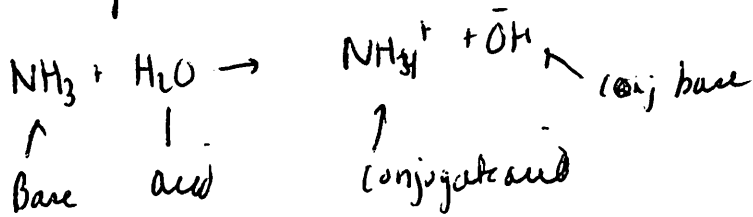


Brinked Lowy and Base Pair

↳ If a B-L acid gives up proton -- now a B-L base (b/c gets a proton).



Same goes for a bare

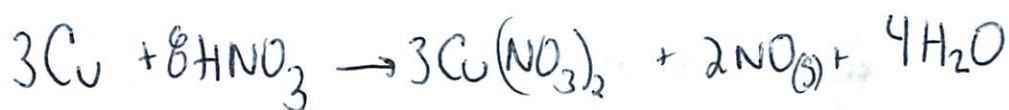
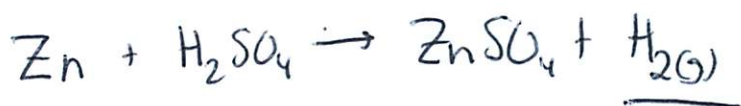


The stronger the acid the weaker the conj base
(vice versa. Use HCl to explain)

descrie amfotere au H_2SO_4

Reactions of acids *Neutralization too!*

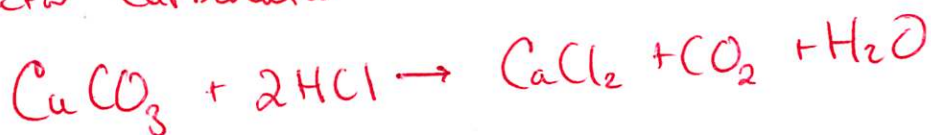
1. acids react w/ metals via single rep reaction



2. React w/ metal oxides



3. React w/ Carbonates



Why important?

B/c most marble statues are deteriorated
in this matter.

pg 469 Q1

475 Q2 Ignorance

479 Q1,2

486 Q1(a,b,c)

Q2(a,c,d)

488 - ~~Q30~~ Q30, Prob 2, 7, 8

489

Q App Q9,

App Prob 5

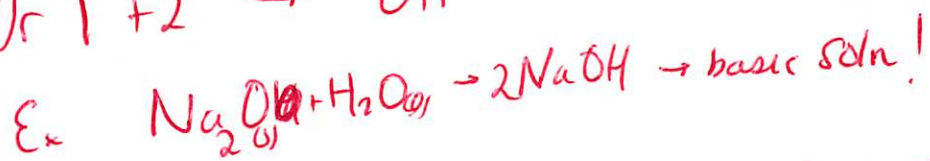
Section 16.4 for H!

Oxides \rightarrow Binary comp of O^{2-} + other element.
Can be ionic metal + O \rightarrow or non metal + O!

Oxides of active metals \rightarrow form OH

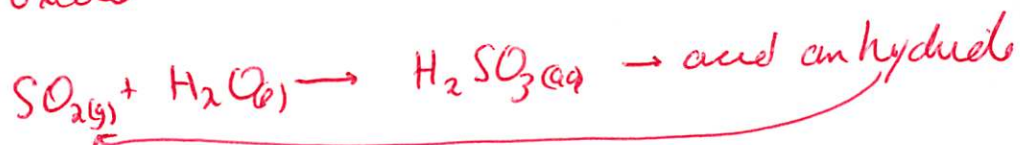


for Gr 1 + 2 \rightarrow OH



Oxide w/ $H_2O \rightarrow$ basic soln called a basic anhydride
 \downarrow \leftarrow mean w/o H_2O
b/c made by loss of H_2O from base

For nonmetal oxides \rightarrow make acids



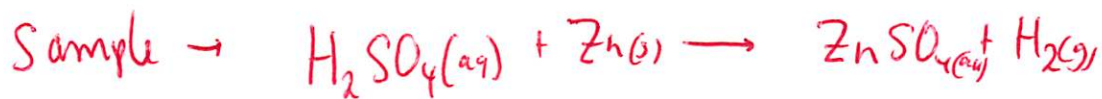
~~Acidic oxides~~ \rightarrow both ~~acidic~~ and ~~basic~~

Organic Acids

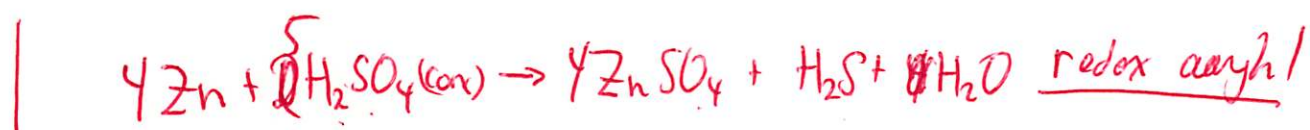
16.5 for H Chemical Rxns for Acids Bases etc

1. Acids React w/ metals

for non oxidizing acids \rightarrow HCl, dil H_2SO_4
act as proton alone



for oxidizing acid \rightarrow ion of acid reacts too to give product!



\rightarrow strong conc H_2SO_4 , HNO_3 , ClO_4 are oxidizing too hard to balance!

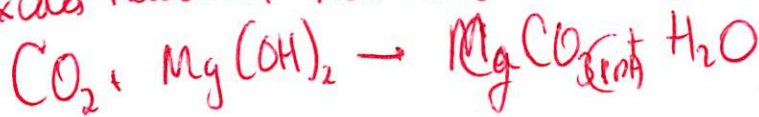
2. Acids react w/ metal oxides



3. Acids react w/ Metal Carbonates



4. Hydroxides react w/ non metal oxides (Lime H_2O !)

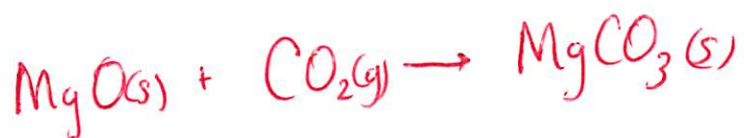


but is reaction dependent



2 possibilities tough!

Metal Oxides w/ nonmetal oxides
↳ oxy salt

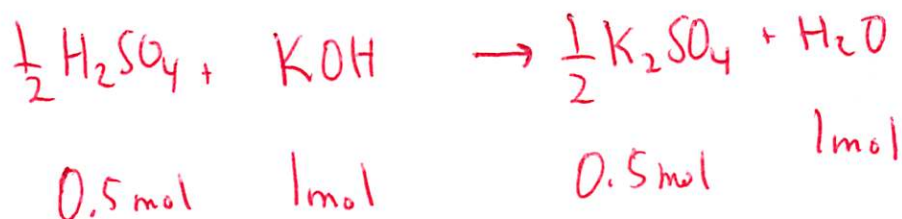
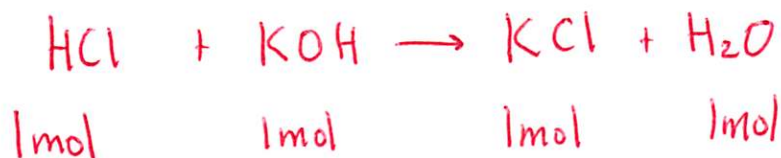


Neutralization Reaction too



Ch 17 Titration + pH

Consider Rxns



b/c H_2SO_4 need $\frac{1}{2}$ as much to neutralize KOH

So 1mol HCl + 0.5mol H_2SO_4 are chemically equivalent
b/c each supply 1mol H^+

Equivalent mass of acid \rightarrow quantity of an acid in(g) that supplies 1mol H^+

Calc for HCl + H_2SO_4

Same for base - equiv. mass of base - quant of base that supplies 1mol OH^-

Ch 17 Hmwk

PS486 Q1

805 Q1, 4

516 Q 3, 4

Prob 6

AP 517 Prob 1

518 5, 9, 11, 17, 21

519 App Prob 7

H before

517 Prob 1

518 Prob 4, 7, 9, 11, 16, 18

519 25

Normality (Another [])

$$\frac{\text{H of equivalents}}{\text{L of soln}}$$

→ Important b/c tells # of equivalents

0.1 N soln HCl same equiv of 0.1 N H_2SO_4

so soln of equal vol = equal H⁺ equiv.

Advantage to N = $\frac{\text{sam}}{\text{vol of soln}} \times \frac{\text{diff}}{\text{equiv. wt}}$ (same N same # of equivalents)

equate M to N $N = n^M$
 ↑
 # of equivalents

40 examples from the book

17.2 Ag Soln + pH

Self ionization \rightarrow water ionizes

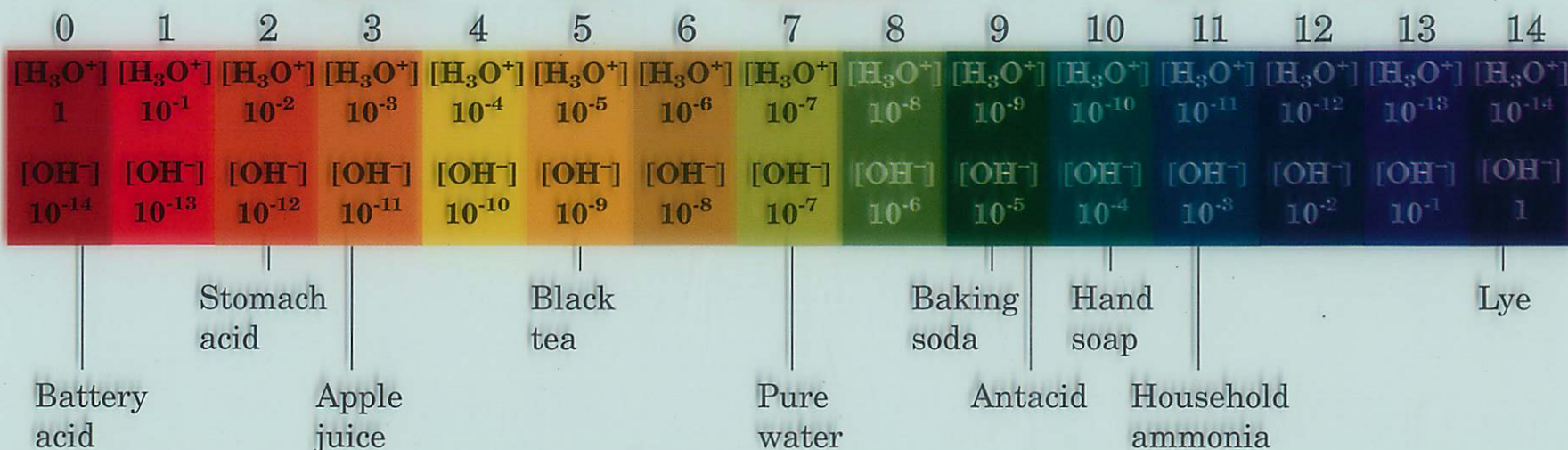


Calculations are $\frac{1 \text{ mol } H^+}{1 \times 10^7 \text{ L } H_2O}$ same for OH^-

$$[H^+] \text{ in } H_2O = 1 \times 10^{-7} M = [OH^-]$$

$[H^+] = [OH^-]$ means neutral

pH Scale Relationships



If $[H^+]$ exceeds $1 \times 10^{-7} M$ acidic

Ex soln $1 \times 10^{-5} M H^+$ - acid

" $[OH^-]$ " " basic

$1 \times 10^{-5} M OH^-$ - base

the product of $[H^+][OH^-]$ always constant

↳ depends on temp @ $25^\circ C$

$$[H^+][OH^-] = 1 \times 10^{-7} M \times 1 \times 10^{-7} M = \frac{1 \times 10^{-14} M^2}{\uparrow}$$

Referred to K_w

ionization const

If one changes the other shifts to allow for same product

pH scale.

↳ using this rationale if the $[H^+]$ is known the other can be determined

b/c

$$[H^+][OH^-] = 1 \times 10^{-14} M^2$$

do calculations

$[H^+] + [OH^-]$ as M can be cumbersome exponent, getting

Use $pH = -\log[H^+]$

pure H_2O @ $25^\circ C$ has $[H^+] = 1 \times 10^{-7} M$

\log_{10} - power to which
10 is raised to
give that #

$$pH = -\log(1 \times 10^{-7} M) = -(-7) = 7$$

We will calculate pH from $[H^+] + [OH^-]$ + $[H^+] + [OH^-] \rightarrow pH$

Calc pH of $0.01 M HCl$

↳ Strong acid so $0.01 M H^+$

$$-\log(0.01) = \underline{2 = pH}$$

Calc pH of $0.01 M NaOH$

1. Calc $[OH^-]$ (strong base) $0.01 M [OH^-]$ since pH need pH

2. ↳ $[H^+]$

3 pH

$$[H^+][0.01 M] = 1 \times 10^{-14} M^2$$

$$[H^+] = 1 \times 10^{-12} M = \underline{pH 12}$$

if not @ a1 use log anyway

Do Reverse Calculation.

pH of HCl soln is 2.4 what is $[H^+]$, $[HCl]$

$$\text{pH } 2.4 \rightarrow \text{antilog}(-2.4) = 0.00398 \text{ M } H^+ \rightarrow 0.00398 \text{ M HCl}$$

pH of NaOH = 12.2 what is $[OH^-]$, $[NaOH]$

$$\text{pH } 12.2 \rightarrow \text{antilog}(-12.2) = 6.31 \times 10^{-13} \text{ M } H^+$$

↑
leads to $[H^+]$

$$[OH^-] = \frac{1 \times 10^{-14} \text{ M}^2}{H^+}$$

$$\rightarrow \cancel{0.016 \text{ M } H^+}$$

$$\underline{0.016 \text{ M NaOH}}$$

For weak species use % dissociation

$$3 \text{ M HC}_2\text{H}_3\text{O}_2 \text{ (5\% dissociate)} [H^+] = \underline{0.15 \text{ M}} \rightarrow \text{pH } 0.82$$

Titration Rxn between acids + bases

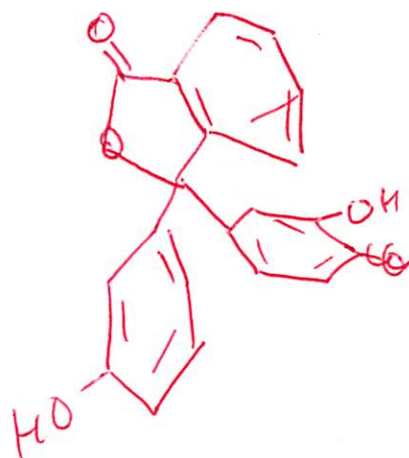


↳ provides sensitive means of determining relative volumes of acidic + basic solns that are equivalent

Def → the controlled addition and measurement of the amount a soln of known $[]$ req. to react completely w/a measured amount of a soln of unknown $[]$

Eq-pt - point at which 2 solns used in titration are chemically equivalent amounts

Titration



Phenolphthalein

As discussed previously Titration ^{is the determination of} ~~is the knowledge of~~ ~~of standard soln concentration~~ $[]$ from a known $[]$.

Used in neutralization Rxns to determine acid or base $[]$'s.

basically when ~~mol A = mol B~~ ~~ph~~ ~~basically new~~

types → 1. Strong acid / Strong Base

Eg pt @ pH 7.

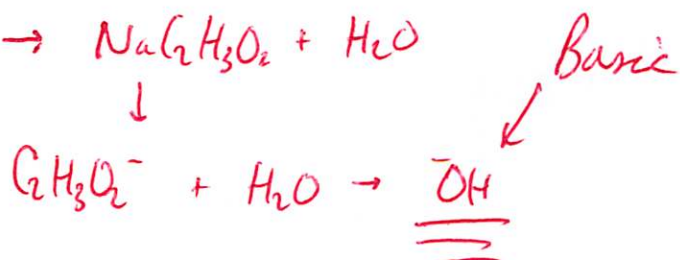
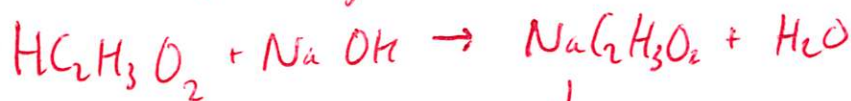
Means that $\text{mol H}^+ = \text{mol OH}^-$ ↓ Not acid / base salt

for example → $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$

Extra

2. Weak acid / Strong Base

Eg Pt above 7 why look @ Rxn



3 For Strong Acid/Weak Base ~~indicator~~
E_{qpt} below 7



So since eq pts are different different indicators are very important.

Choose indicators wisely!

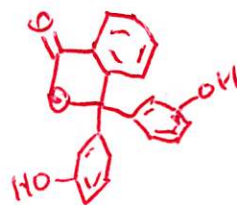
Indicators themselves are weak acids



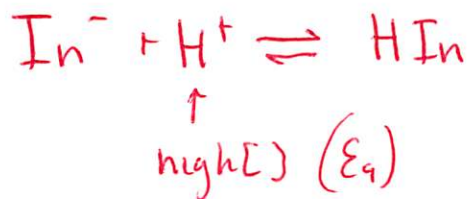
diff.

Colors

For phenolphthalein - show α -form.

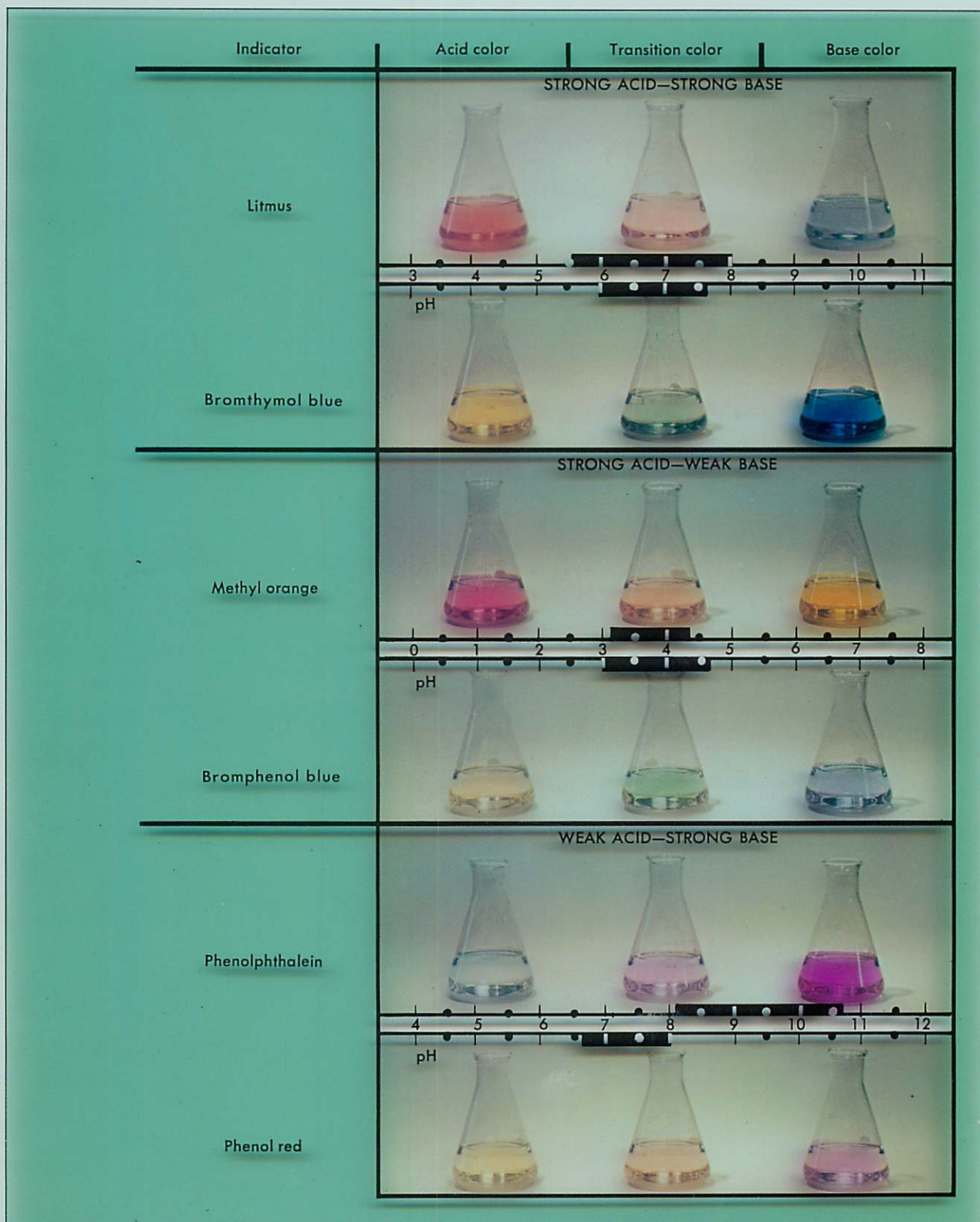


In acid soln HI is most common b/c

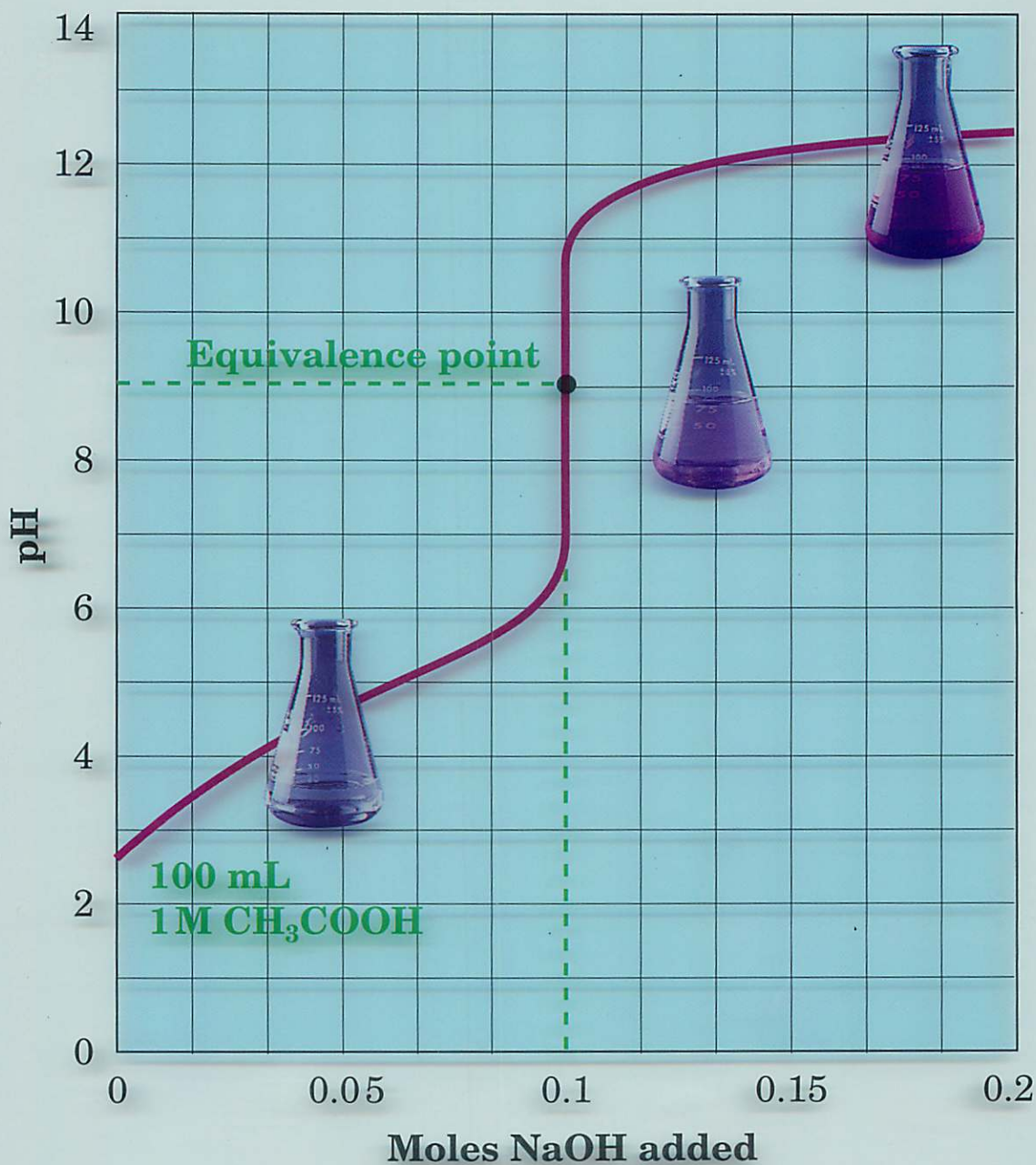


In basic soln $\text{HIn} + \text{OH}^- \rightleftharpoons \text{In}^- + \text{H}_2\text{O}$

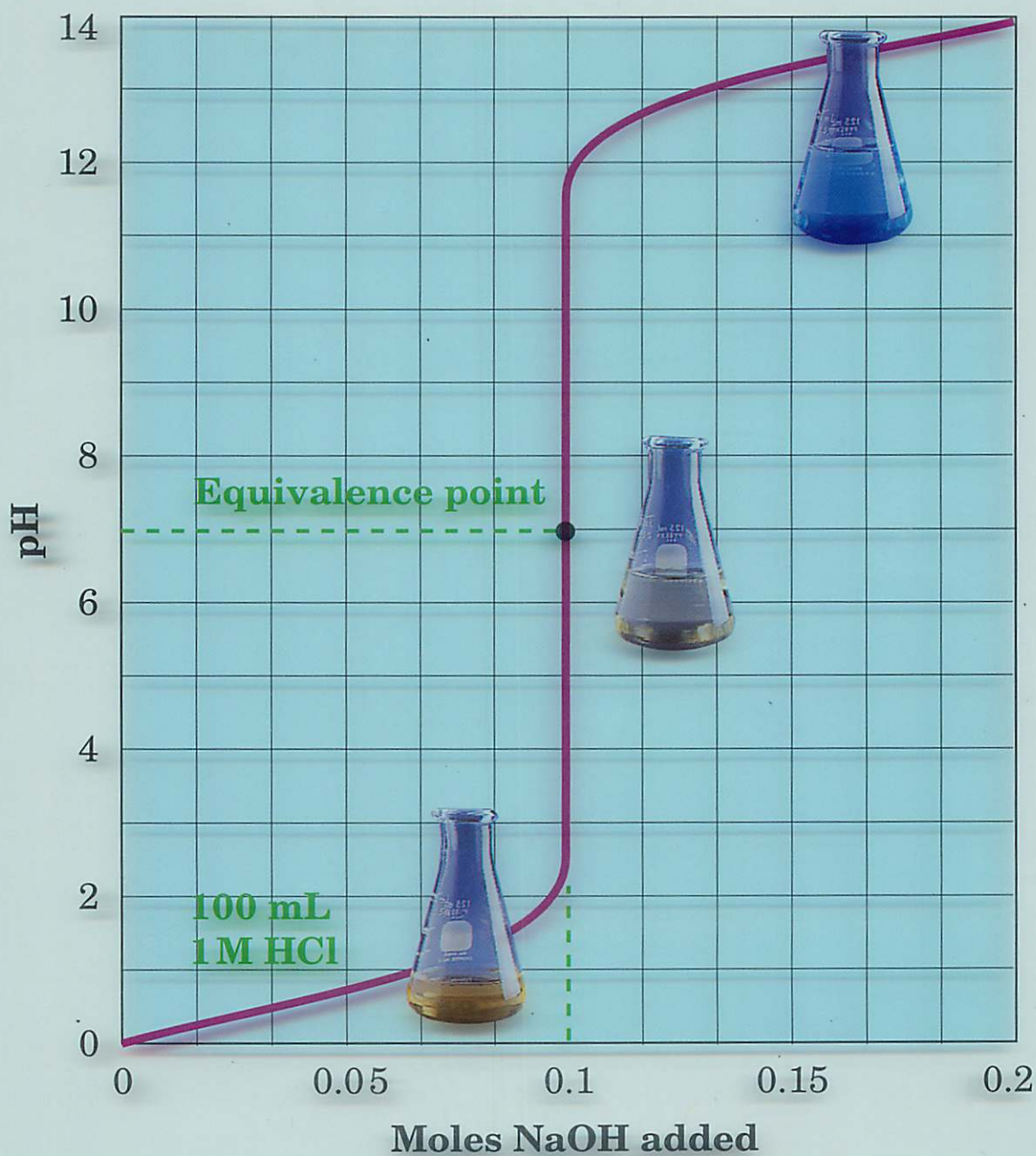
Dark color @ lower pH
levels b/c some are
stronger acids



Titration Curve for a Weak Acid and a Strong Base



Titration Curve for a Strong Acid and a Strong Base



Choose indicator based on pH range where color Δ occurs

for $SA + SB \rightarrow$ pH 7 Range

$WA + SB \rightarrow \uparrow 7$

$SA + WB \rightarrow \downarrow 7$

Show Overhead.

Theory Behind Titration.

It is a neutralization rxn.



used to find $[]$ of unknown.

for 1 : 1 ratio use molarity $M_A V_A = M_B V_B$

for polyprotic + polyhydroxides ^{bases} $N_A V_A = N_B V_B$

\downarrow
B/c Eq are important!

Explain + do problems